(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 May 2001 (03.05.2001)

PCT

(10) International Publication Number
WO 01/31739 A1

(51) International Patent Classification[7]: H01Q 1/38

(21) International Application Number: PCT/US00/27855

(22) International Filing Date: 6 October 2000 (06.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/158,506 8 October 1999 (08.10.1999) US

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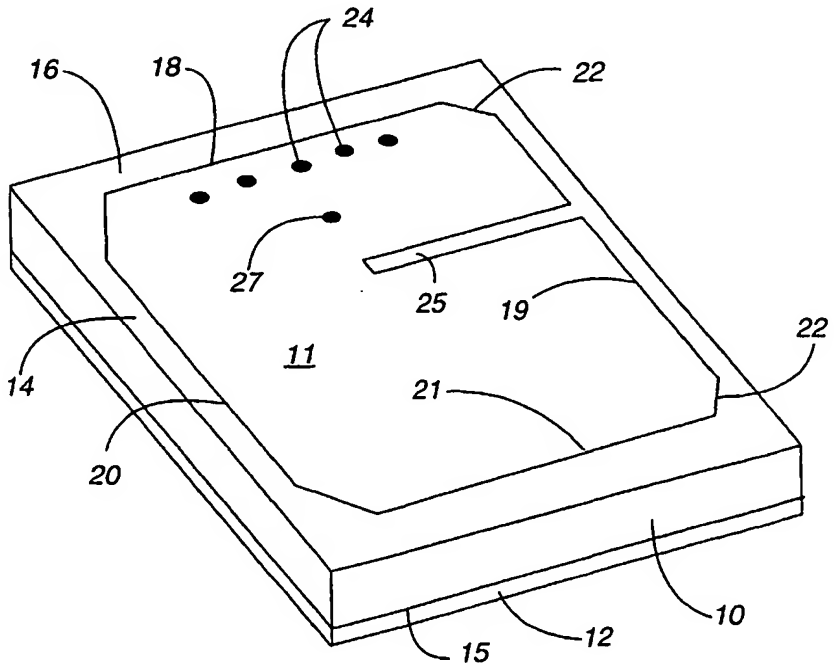
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AT (utility model), AU (petty patent), AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

[Continued on next page]

(54) Title: COMPACT MICROSTRIP ANTENNA FOR GPS APPLICATIONS



(57) Abstract: A compact microstrip antenna particularly suited for GPS applications includes a dielectric (10), a square radiating element (11) with chamfered corners (22) and a truncated ground plane (12). The radiating element (11) has a reactance window (25) to lengthen the current path and a feed point (27). The radiating element (11) is partially shorted to the ground plane (12). The reactance window (25) and partial shorting reduce the size of the radiating element (11). The antenna is compact with good isotropic characteristics and sensitivity to circular polarization.

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— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

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COMPACT MICROSTRIP ANTENNA FOR GPS APPLICATIONS

This application claims the benefit under 35 U.S.C. § 119(e) of the U.S. provisional patent application no. 60/158,506 filed October 8, 1999.

Technical Field

The present invention relates to antennas and more particularly to a compact microstrip antenna that is particularly suitable for Global Positioning System (GPS) applications.

Background Art

Prior known devices for GPS have generally been hand held or vehicle mounted. The antennas for these GPS applications have generally been helix antennas or multilayer patch antennas. These antennas are complex and relatively expensive to manufacture.

In GPS applications worn on the body, such as for prisoner tracking, the body can interfere with the antenna function and the antenna must be capable of efficient function at any rotation in free space. Antennas for such GPS systems must have good isotropic characteristics and be sensitive to circular polarization.

Disclosure of the Invention

A compact microstrip antenna having a dielectric with a radiating element on a first side and a ground plane on a second side is disclosed. The radiating element disclosed is substantially square with chamfered corners The radiating element is partially shorted along a first edge to the ground plane through shorting posts

extending through the dielectric. The radiating element includes a reactance window parallel to and spaced from the first edge, and a feed point between the first edge and the reactance window.

Brief Description of the Drawings

Details of this invention are described in connection with the accompanying drawings that bear similar reference numerals in which:

Figure 1 is a perspective view of an antenna embodying features of the present invention.

Figure 2 is a top plan view of the antenna of Figure 1.

Figure 3 is a bottom plan view of the antenna of Figure 1.

Detailed Description Of The Invention

Referring now to Figures 1, 2 and 3 the compact antenna embodying features of the present invention includes a dielectric 10, a radiating element 11, and a ground plane 12. The dielectric 10 is generally a thin planar layer with a square outline, and includes a planar first side 14 and a spaced, oppositely facing planar second side 15.

The radiating element 11 is a substantially square thin layer of conductive material such as copper disposed on the first side 14 of the dielectric 10. The radiating element 11 is slightly smaller than the first side 14 and a border 16 of first side 14 extends around the radiating element 11. The radiating element 11 has a first edge 18, spaced second and third edges 19 and 20

extending transversely from opposite ends of the first edge 18, and a fourth edge 21, spaced from the first edge 18 and extending between the second and third edges 19 and 20.

The corners connecting the first, second, third and fourth edges 18, 19, 20 and 21 are chamfered so that the first, second, third and fourth edges 18, 19, 20 and 21 are connected by chamfer sections 22. Preferably the chamfer sections 22 extend at 45 degrees relative to the first, second, third and fourth edges 18, 19, 20 and 21. The chamfer sections 22 are preferably sized to reduce the length each of the first, second, third and fourth edges 18, 19, 20 and 21 by about 10% at each end, so that the length of the first and fourth edges 18 and 21 is about 80% of the distance from the second edge 19 to the third edge 20 and the length of the second and third edges 19 and 20 is about 80% of the distance from the first edge 18 to the fourth edge 21.

The ground plane 12 is truncated, having an area slightly larger than the area of the radiating element 11, and is disposed over substantially the entire second side 15 of the dielectric 10. The antenna includes means for partially shorting the first edge 18 of the radiating element 11 to the ground plane 12. The first edge 18 of the radiating element 11 is considered to be partially shorted because only a portion of the first edge 18 of is connected to the ground plane 12 instead of the entire first edge 18 of the radiating element 11. In the illustrated embodiment the means for partially shorting includes a plurality of uniformly spaced shorting posts 24 in the form of plated through holes extending through the dielectric 10 and electrically connecting a portion of the first edge 18 to the ground

plane 12. The shorting posts 24 are linearly arranged along and as close as possible to the first edge 18 and are substantially centered along the first edge 18. The means for partially shorting may alternatively include conductive tape or a tab extending around the dielectric 10 from the first edge 18 of the radiating element 11 to the ground plane 12. The width of the means for partially shorting is preferably 35% to 55% of the distance from the second edge 19 to the third edge 20.

A reactance window 25, in the form of a narrow rectangular strip cut into the radiating element 11, extends parallel to and spaced from the first edge 18 opening inward from the second edge 19 and extending towards the third edge 20 of the radiating element 11. The radiating element 11 includes a feed point 27 located between the first edge 18 and the reactance window 25 and substantially centered between the second edge 19 and the third edge 20. In the illustrated embodiment the feed point 27 includes a plated through hole through the dielectric 10. The feed point 27 may alternatively include a non-plated hole. The ground plane 12 includes an opening 28 around the feed point 27 on the second side 15 of the dielectric 10 so that the feed point 27 is electrically isolated from the ground plane 12. A coaxial cable (not shown) in the embodiment shown may be attached to the antenna with the center conductor of the coaxial cable connecting to the feed point 27 at the second side 15 of the dielectric 10 and the outer conductor of the coaxial cable connecting to the ground plane 12.

By way of example, and not a limitation, an antenna as described above can be dimensioned as follows for GPS applications. The dielectric 10 and the ground plane 12 each have a length of 24 mm and a width of 24

mm. The dielectric is 3 mm thick. The radiating element 11 is 22 mm wide and 22 mm long. The corners of the radiating element are chamfered about 2 mm so that the first, second, third and fourth edges 18, 19, 20 and 21 are each 18 mm long and the chamfer sections 22 are about 2.8 mm. There are five shorting posts 24, each 1 mm in diameter, spaced at regular intervals of about 2 mm to 3 mm so that the span between outside shorting posts 24 is between 8 mm and 12 mm. The reactance window 25 is spaced 8 mm from the first edge 18, extends inward 11 mm from the second edge 19 and is 0.5 mm wide. The feed point 27 is 1.4 mm in diameter, and is spaced 3 or 4 mm from the first edge 20. The opening 28 in the ground plane 12, around the feed point 27 is 2.8 mm in diameter.

The antenna may be constructed of any other substrate material. An exemplary material is MC3D Medium Frequency Laminate from GIL technologies, Collierville, Tennessee, with a dielectric constant of about 3.86. The partial shorting of the radiating element 11 to the ground plane 12 reduces the size of the radiating element 11. The reactance window 25 reduces the size of the radiating element 11 and increases the amount of diffracted waves, which improves the isotropic characteristics of the antenna and helps make the antenna sensitive to two perpendicular linear polarizations. The square radiating element 11 and the chamfered sections 22 increase the sensitivity to circular polarization. The truncation of the ground plane 12 reduces the antenna size and improves the isotropic characteristics. The antenna of the present invention is significantly simpler and less expensive to manufacture than prior known antennas for GPS applications.

Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made by way of example and that changes in details of structure may be made without departing from the spirit thereof.

What is Claimed is:

1. A compact microstrip antenna comprising:

a dielectric having a first side and a spaced, oppositely facing second side,

a substantially square radiating element on said first side having a first edge, spaced second and third edges extending transverse to said first edge and a fourth edge extending between said second and third edge opposite said first edge, said first edge being connected at opposite ends to said second and third edges by chamfer sections, said fourth edge being connected at opposite ends to said second and third edges by chamfer sections, said radiating element having a reactance window spaced from said first edge and opening through and extending inward from and transverse to said second edge,

a ground plane on said second side, and

means, connected between said first edge of said radiating element and said ground plane, for partially shorting said radiating element to said ground plane.

2. The antenna of Claim 1 wherein said ground plane is truncated.

3. The antenna of Claim 1 wherein said means for partially shorting includes a plurality of uniformly spaced shorting posts each extending through said dielectric from said ground plane to said radiating element, said shorting posts being generally linearly disposed along a portion of said first edge of said radiating element.

4. The antenna of Claim 3 wherein plurality of shorting posts is centered between said second and third edges.

5. The antenna of Claim 1 wherein said means for partially shorting has a width that is about 35% to 55% of the distance between said second and third sides.

6. The antenna of Claim 1 wherein said chamfer sections connect at 45 degree angles to said first, second, third and fourth edges.

7. The antenna of Claim 1 wherein said chamfer sections are sized such that the length of said first edge and said fourth edge is about 80% of the distance from said second edge to said third edge and the length of second edge and said third edge is about 80% of the distance from said first edge to said fourth edge.

8. The antenna of Claim 1 wherein said radiating element includes a feed point located between said first edge and said reactance window.

9. The antenna of Claim 8 wherein said feed point includes a plated through hole extending through said dielectric and said ground plane includes an opening around said plated through hole to electrically isolate said feed point from said ground plane.

10. A compact microstrip antenna with good isotropic characteristics and sensitivity to circular polarization, and particularly suited for GPS applications comprising:

a substantially square, planar dielectric having a first side and a spaced, oppositely facing second side,

a substantially square radiating element on said first side having a first edge, spaced second and third edges extending transverse to said first edge and a fourth edge extending between said second and third edge

opposite said first edge, said first edge being connected at opposite ends to said second and third edges by chamfer sections, said fourth edge being connected at opposite ends to said second and third edges by chamfer sections, said chamfer sections connecting at 45 degree angles to said first, second, third and fourth edges and sized such that the length of said first edge and said fourth edge is about 80% of the distance from said second edge to said third edge and the length of second edge and said third edge is about 80% of the distance from said first edge to said fourth edge, said radiating element including a reactance window spaced from said first edge and opening through and extending inward from and transverse to said second edge, said radiating element including a feed point located between said first edge and said reactance window, said feed point including a plated through hole extending through said dielectric,

a truncated ground plane on said second side, said ground plane including an opening around said plated through hole to electrically isolate said feed point from said ground plane and

a plurality of uniformly spaced shorting posts each extending through said dielectric from said ground plane to said radiating element, said plurality of shorting posts being generally linearly disposed along a portion of said first edge of said radiating element and substantially centered between second and third edges for partially shorting said radiating element to said ground plane.

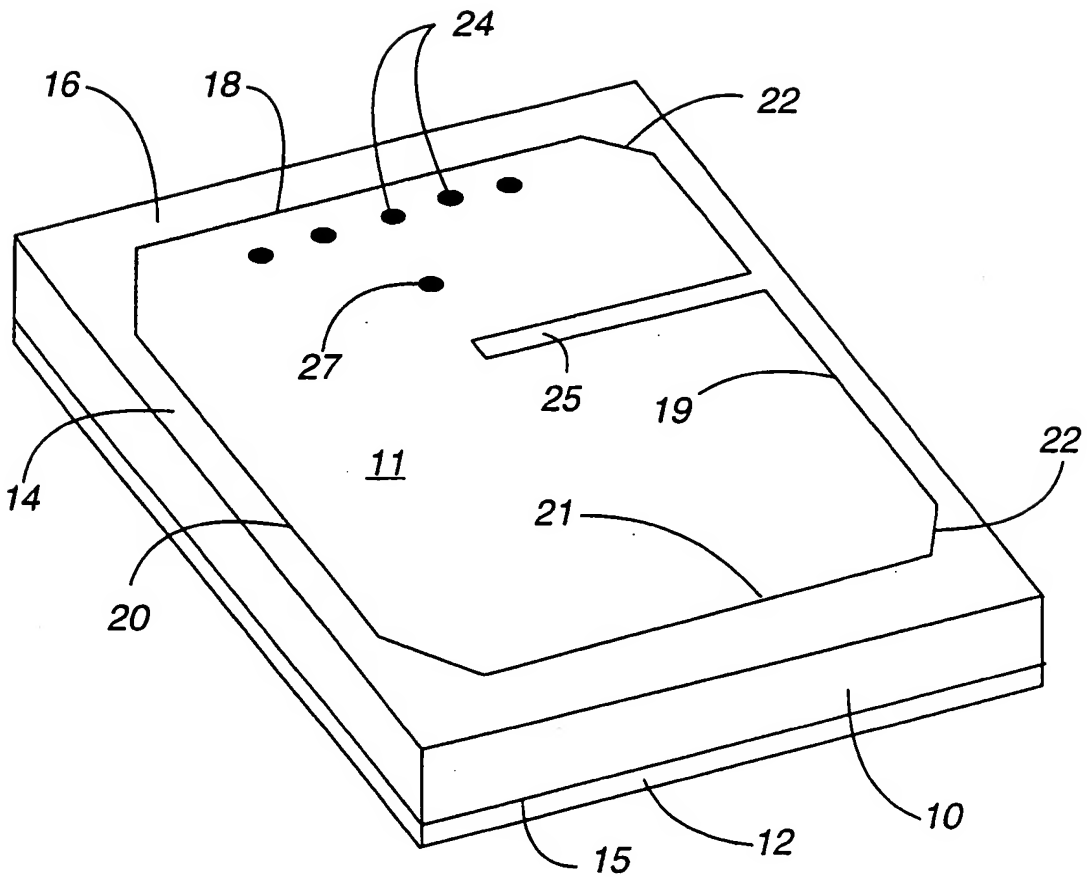

Fig. 1

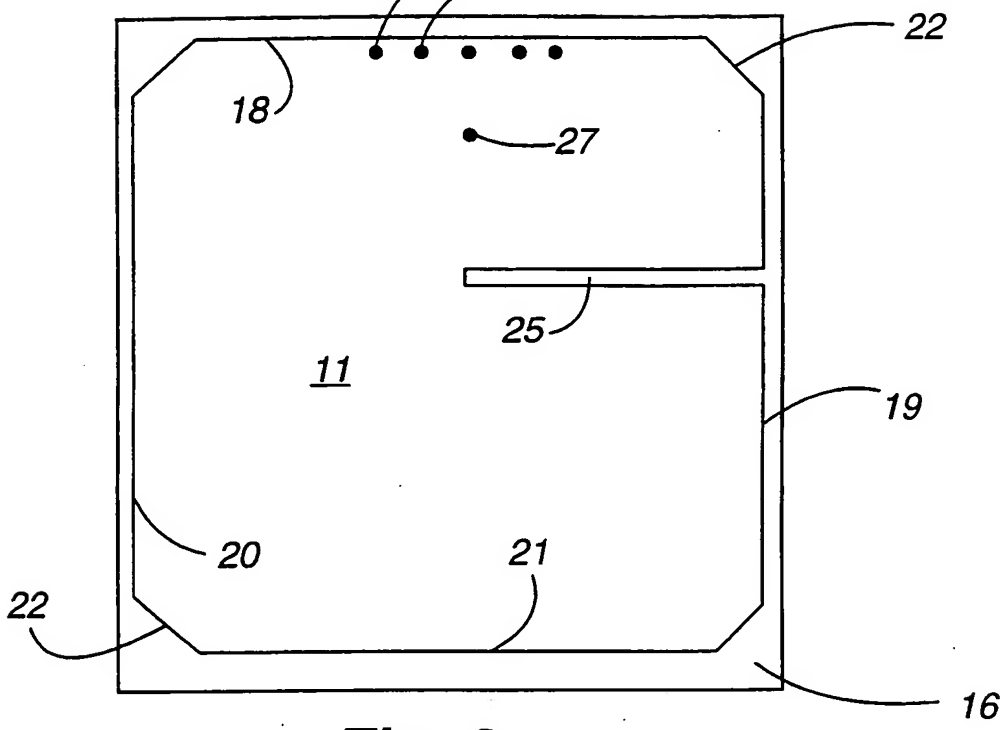

Fig. 2

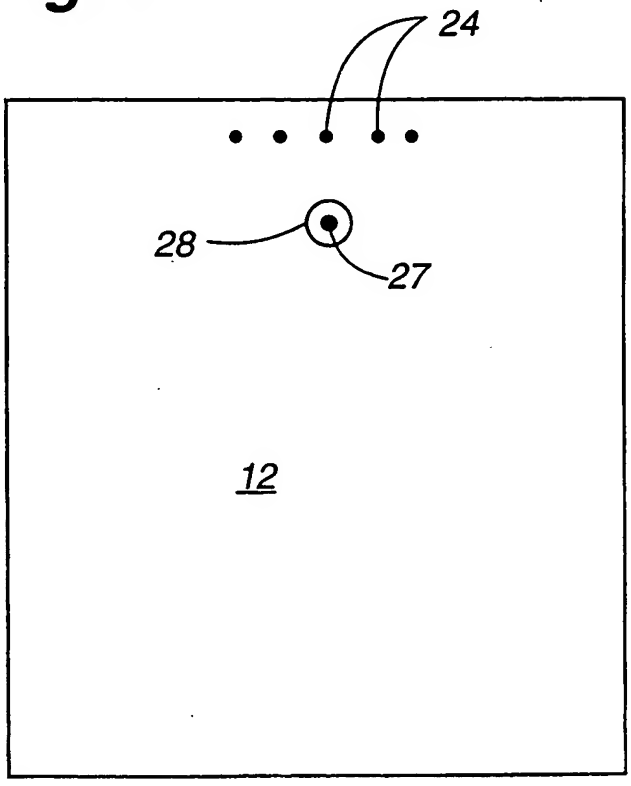

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/27855

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H01Q 1/38
US CL :343/700MS

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 343/700MS, 702

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,E	US 6,140,966 A (PANKINAHO) 31 October 2000 (31.10.2000), fig. 1.	1-10
Y,E	US 6,140,968 A (KAWAHATA et al) 31 October 2000 (31.10.2000), fig. 1.	1-10
Y	US 4,040,060 A (KALOI) 02 August 1977 (02.08.1977), fig. 1a.	4, 5, 7, 9, 10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 MARCH 2001	05 APR 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JAMES CLINGER Telephone No. (703) 305-0619

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